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Markov Models Hidden Markov Models and Dynamical Systems Hidden Markov Models Hidden Markov Models Hidden Markov Models Theory of Continuous-State Hidden Markov Models and Hidden Gauss-Markov Models Hidden Markov Model Inference in Hidden Markov Models Incremental Learning of Discrete Hidden Markov Models Incremental Learning of Discrete Hidden Markov Models Hidden Markov Models and Dynamical Systems Latent Markov Models for Longitudinal Data The Data Science Handbook Hidden Markov Models Hidden Markov Models for Bioinformatics Economic Growth and Convergence Monte Carlo Hidden Markov Models 2 New Approaches for Learning HMMs Markov Models for Pattern Recognition Hidden Markov Models and Applications An Introduction to Queueing Theory Semi-Markov Chains and Hidden Semi-Markov Models toward Applications Hidden Markov Processes Discriminative Learning for Speech Recognition Hidden Markov Models for Time Series Data Mining, Southeast Asia Edition Finite Mixture and Markov Switching Models A Baum-Welch Algorithm for Noisy Vector Fields for Classification and Synthesis of Textures Using Non-Symmetric Half-Plane Hybrid Intelligent Techniques for Pattern Analysis and Understanding Hidden Markov Models for Bioinformatics Modeling Expressive Musical Performance with Hidden Markov Models Readings in Speech Recognition Texture Analysis Using a Markov Model The Man Who Solved the Market Modelling, Computation and Optimization in Information Systems and Management Sciences Speech & Language Processing Graphical Models Conditional Baum-Welch, Dynamic Model Surgery, and the Three-Poisson Dempster-Shafer Model Encyclopedia of Operations Research and Management Science Efficient Learning Machines

Hybrid Intelligent Techniques for Pattern Analysis and Understanding outlines the latest research on the development and application of synergistic approaches to pattern analysis in real-world scenarios. An invaluable resource for lecturers, researchers, and graduates students in computer science and engineering, this book covers a diverse range of hybrid intelligent techniques, including image segmentation, character recognition, human behavioral analysis, hyperspectral data processing, and medical image analysis. Abstract: "We present a learning algorithm for hidden Markov models with continuous state and observation spaces. All necessary probability density functions are approximated using samples, along with density trees generated from such samples. A Monte Carlo version of Baum-Welch (EM) is employed to learn models from data, just as in regular HMM learning. Regularization during learning is obtained using an exponential shrinking technique. The shrinkage factor, which determines the effective capacity of the learning algorithm, is annealed down over multiple iterations of Baum-Welch, and early stopping is applied to select the right model. We prove that under mild assumptions, Monte Carlo Hidden Markov Models converge to a local maximum in likelihood space, just like conventional HMMs. In addition, we provide empirical results obtained in a gesture recognition domain, which illustrate the appropriateness of the approach in practice." Hidden Markov Models (HMMs), although known for decades, have made a big career nowadays and are still in state of development. This book presents theoretical issues and a variety of HMMs applications in speech recognition and synthesis, medicine, neurosciences, computational biology, bioinformatics, seismology, environment protection and engineering. I hope that the reader will find this book useful and helpful for their own research. Our ability to generate and collect data has been increasing rapidly. Not only are all of our business, scientific, and government transactions now computerized, but the widespread use of digital cameras, publication tools, and bar codes also generate data. On the collection side, scanned text and image platforms, satellite remote sensing systems, and the World Wide Web have flooded us with a tremendous amount of data. This explosive growth has generated an even more urgent need for new techniques and automated tools that can help us transform this data into useful information and knowledge. Like the first edition, voted the most popular data mining book by KD Nuggets readers, this book explores concepts and techniques for the discovery of patterns hidden in large data sets, focusing on issues relating to their feasibility, usefulness, effectiveness, and scalability. However, since the publication of the first edition, great progress has been made in the development of new data mining methods, systems, and applications. This new edition substantially enhances the first edition, and new chapters have been added to address recent developments on mining complex types of data— including stream data, sequence data, graph structured data, social network data, and multi-relational data. A comprehensive, practical look at the concepts and techniques you need to know to get the most out of real business data Updates that incorporate input from readers, changes in the field, and more material on statistics and machine learning Dozens of algorithms and implementation examples, all in easily understood pseudo-code and suitable for use in real-world, large-scale data mining projects Complete classroom support for instructors at www.mkp.com/datamining2e companion site We address the problem of learning discrete hidden Markov models from very long sequences of observations. Incremental versions of the Baum-Welch algorithm that approximate the beta-values used in the backward procedure are commonly used for this problem since their memory complexity is independent of the sequence length. However, traditional approaches have two main disadvantages: the approximation of the beta-values deviates far from the real values, and the learning algorithm requires previous knowledge of the topology of the model. This dissertation describes a new incremental Baum-Welch algorithm with a novel backward procedure that improves the approximation of the â-values based on a one-step lookahead in the training sequence and investigates heuristics to prune unnecessary states from an initial complex model. Two new approaches for pruning, greedy and controlled, are introduced and a novel method for identification of ill-conditioned models is presented. Incremental learning of multiple independent observations is also investigated. We justify the new approaches analytically and report empirical results that show they converge faster than the traditional Baum-Welch algorithm using fewer computer resources. Furthermore, we demonstrate that the new learning algorithms converge faster than the previous incremental approaches and can be used to perform online learning of high-quality models useful for classification tasks. Finally, this dissertation explores the use of the new algorithms for anomaly detection in computer systems, that improve our previous research work on detectors based on hidden Markov models integrated into real-world monitoring systems of high-performance computers. After more than two decades of research activity, speech recognition has begun to live up to its promise as a practical technology and interest in the field is growing dramatically. Readings in Speech Recognition provides a collection of seminal papers that have influenced or redirected the field and that illustrate the central insights that have emerged over the years. The editors provide an introduction to the field, its concerns and research problems. Subsequent chapters are devoted to the main schools of thought and design philosophies that have motivated different approaches to speech recognition system design. Each chapter includes an introduction to the papers that highlights the major insights or needs that have motivated an approach to a problem and describes the commonalities and differences of that approach to others in the book. In this paper we present a statistical model with a non-symmetric half-plane (NSHP) region of support for two-dimensional continuous-valued vector fields. It has the simplicity, efficiency, and ease of use of the well-known hidden Markov model (HMM) and associated Baum-Welch algorithms for time-series and other one-dimensional problems. At the same time, it is able to learn textures on a two-dimensional field. We describe a fast approximate forward procedure for computation of the joint probability density function (PDF) of the vector field as well as an approximate Baum-Welch algorithm for parameter re-estimation. We test the method using synthetic textures. A general theory of continuous-state hidden Markov models is developed, with continuous-state analogs of the Baum, Viterbi, and Baum-Welch algorithms formulated for this class of models. The algorithms are specialized to models with linear Gaussian densities, thereby unifying the theory of hidden Markov models and Kalman filters. The Baum and Viterbi algorithms for Gaussian models are shown to be implemented by two different formulations of the fixed-interval Kalman smoother. Moreover, the measurement likelihoods obtained from the forward pass of the Baum algorithm and from the

Kalman-filter Innovation sequence are found to be equivalent A direct link between the Baum-Welch algorithm and an existing expectation-maximization algorithm for linear Gaussian models is demonstrated. The general continuous-state and Gaussian models are extended to incorporate mixture densities for the prior probability of the initial state. For the Gaussian models, a new expression for the cross covariance between time adjacent states is derived from the off-diagonal block of the conditional joint covariance matrix and a parameter invariance structure is observed when the system matrices are time invariant. This text is based on a set of not es produced for courses given for gradu ate students in mathematics, computer science and biochemistry during the academic year 1998-1999 at the University of Turku in Turku and at the Royal Institute of Technology (KTH) in Stockholm. The course in Turku was organized by Professor Mats Gyllenberg's groupl and was also included 2 within the postgraduate program ComBi , a Graduate School in Compu tational Biology, Bioinformatics, and Biometry, directed by Professor Esko Ukkonen at the University of Helsinki. The purpose of the courses was to give a thorough and systematic intro duc ti on to probabilistic modelling in bioinformatics for advanced undergraduate and graduate students who had a fairly limited background in prob ability theory, but were otherwise well trained in mathematics and were already familiar with at least some of the techniques of algorithmic sequence analysis. Portions of the material have also been lectured at shorter graduate courses and seminars both in Finland and in Sweden. The initial set of notes circulated also for a time outside those two countries via the World Wide Web. The intermediate course in probability theory and techniques of discrete mathematics held by the author at the University College of Södertörn (Hud dinge, Sweden) during the academic year 1997-1998 has also influenced the presentation. The opportunity to give this course is hereby gratefully ac knowledged. Machine learning techniques provide cost-effective alternatives to traditional methods for extracting underlying relationships between information and data and for predicting future events by processing existing information to train models. Efficient Learning Machines explores the major topics of machine learning, including knowledge discovery, classifications, genetic algorithms, neural networking, kernel methods, and biologically-inspired techniques. Mariette Awad and Rahul Khanna’s synthetic approach weaves together the theoretical exposition, design principles, and practical applications of efficient machine learning. Their experiential emphasis, expressed in their close analysis of sample algorithms throughout the book, aims to equip engineers, students of engineering, and system designers to design and create new and more efficient machine learning systems. Readers of Efficient Learning Machines will learn how to recognize and analyze the problems that machine learning technology can solve for them, how to implement and deploy standard solutions to sample problems, and how to design new systems and solutions. Advances in computing performance, storage, memory, unstructured information retrieval, and cloud computing have coevolved with a new generation of machine learning paradigms and big data analytics, which the authors present in the conceptual context of their traditional precursors. Awad and Khanna explore current developments in the deep learning techniques of deep neural networks, hierarchical temporal memory, and cortical algorithms. Nature suggests sophisticated learning techniques that deploy simple rules to generate highly intelligent and organized behaviors with adaptive, evolutionary, and distributed properties. The authors examine the most popular biologically-inspired algorithms, together with a sample application to distributed datacenter management. They also discuss machine learning techniques for addressing problems of multi-objective optimization in which solutions in real-world systems are constrained and evaluated based on how well they perform with respect to multiple objectives in aggregate. Two chapters on support vector machines and their extensions focus on recent improvements to the classification and regression techniques at the core of machine learning. Presents algorithms for using HMMs and explains the derivation of those algorithms for the dynamical systems community. This book is a comprehensive treatment of inference for hidden Markov models, including both algorithms and statistical theory. Topics range from filtering and smoothing of the hidden Markov chain to parameter estimation, Bayesian methods and estimation of the number of states. In a unified way the book covers both models with finite state spaces and models with continuous state spaces (also called state-space models) requiring approximate simulation-based algorithms that are also described in detail. Many examples illustrate the algorithms and theory. This book builds on recent developments to present a self-contained view. This book presents, in an integrated form, both the analysis and synthesis of three different types of hidden Markov models. Unlike other books on the subject, it is generic and does not focus on a specific theme, e.g. speech processing. Moreover, it presents the translation of hidden Markov models’ concepts from the domain of formal mathematics into computer codes using MATLAB®. The unique feature of this book is that the theoretical concepts are first presented using an intuition-based approach followed by the description of the fundamental algorithms behind hidden Markov models using MATLAB®. This approach, by means of analysis followed by synthesis, is suitable for those who want to study the subject using a more empirical approach. Key Selling Points: Presents a broad range of concepts related to Hidden Markov Models (HMM), from simple problems to advanced theory Covers the analysis of both continuous and discrete Markov chains Discusses the translation of HMM concepts from the realm of formal mathematics into computer code Offers many examples to supplement mathematical notation when explaining new concepts This book focuses on recent advances, approaches, theories, and applications related Hidden Markov Models (HMMs). In particular, the book presents recent inference frameworks and applications that consider HMMs. The authors discuss challenging problems that exist when considering HMMs for a specific task or application, such as estimation or selection, etc. The goal of this volume is to summarize the recent advances and modern approaches related to these problems. The book also reports advances on classic but difficult problems in HMMs such as inference and feature selection and describes real-world applications of HMMs from several domains. The book pertains to researchers and graduate students, who will gain a clear view of recent developments related to HMMs and their applications. Includes new advances on finite and infinite Hidden Markov Models (HMMs) and their applications from different disciplines; Tackles recent challenges related to the deployment of HMMs in real-life applications (e.g., big data, multimodal data, etc.); Presents new applications of HMMs by considering advancements with respect to inference techniques and recent technological advancements. Hidden Markov Models for Time Series: An Introduction Using R, Second Edition illustrates the great flexibility of hidden Markov models (HMMs) as general-purpose models for time series data. The book provides a broad understanding of the models and their uses. After presenting the basic model formulation, the book covers estimation, forecasting, decoding, prediction, model selection, and Bayesian inference for HMMs. Through examples and applications, the authors describe how to extend and generalize the basic model so that it can be applied in a rich variety of situations. The book demonstrates how HMMs can be applied to a wide range of types of time series: continuous-valued, circular, multivariate, binary, bounded and unbounded counts, and categorical observations. It also discusses how to employ the freely available computing environment R to carry out the computations. Features Presents an accessible overview of HMMs Explores a variety of applications in ecology, finance, epidemiology, climatology, and sociology Includes numerous theoretical and programming exercises Provides most of the analysed data sets online New to the second edition A total of five chapters on extensions, including HMMs for longitudinal data, hidden semi-Markov models and models with continuous-valued state process New case studies on animal movement, rainfall occurrence and capture-recapture data In this book, we introduce the background and mainstream methods of probabilistic modeling and discriminative parameter optimization for speech recognition. The specific models treated in depth include the widely used exponential-family distributions and the hidden Markov model. A detailed study is presented on unifying the common objective functions for discriminative learning in speech recognition, namely maximum mutual information (MMI), minimum classification error, and minimum phone/word error. The unification is presented, with rigorous mathematical analysis, in a common rational-function form. This common form enables the use of the growth transformation (or extended Baum-Welch) optimization framework in discriminative learning of model parameters. In addition to all the necessary introduction of the background and tutorial material on the subject, we also included technical details on the derivation of the parameter optimization formulas for exponential-family distributions, discrete hidden Markov models (HMMs), and continuous-density HMMs in discriminative learning. Selected experimental results obtained by the authors in firsthand are presented to show that discriminative learning can lead to superior speech recognition performance over conventional parameter learning. Details on major algorithmic implementation issues with practical significance are provided to enable the practitioners to directly

reproduce the theory in the earlier part of the book into engineering practice. Audience: Anyone concerned with the science, techniques and ideas of how decisions are made."--BOOK JACKET. This thoroughly revised and expanded new edition now includes a more detailed treatment of the EM algorithm, a description of an efficient approximate Viterbi-training procedure, a theoretical derivation of the perplexity measure and coverage of multi-pass decoding based on n-best search. Supporting the discussion of the theoretical foundations of Markov modeling, special emphasis is also placed on practical algorithmic solutions. Features: introduces the formal framework for Markov models; covers the robust handling of probability quantities; presents methods for the configuration of hidden Markov models for specific application areas; describes important methods for efficient processing of Markov models, and the adaptation of the models to different tasks; examines algorithms for searching within the complex solution spaces that result from the joint application of Markov chain and hidden Markov models; reviews key applications of Markov models. The purpose of this book is to give a thorough and systematic introduction to probabilistic modeling in bioinformatics. The book contains a mathematically strict and extensive presentation of the kind of probabilistic models that have turned out to be useful in genome analysis. Questions of parametric inference, selection between model families, and various architectures are treated. Several examples are given of known architectures (e.g., profile HMM) used in genome analysis. A comprehensive overview of data science covering the analytics, programming, and business skills necessary to master the discipline Finding a good data scientist has been likened to hunting for a unicorn: the required combination of technical skills is simply very hard to find in one person. In addition, good data science is not just rote application of trainable skill sets; it requires the ability to think flexibly about all these areas and understand the connections between them. This book provides a crash course in data science, combining all the necessary skills into a unified discipline. Unlike many analytics books, computer science and software engineering are given extensive coverage since they play such a central role in the daily work of a data scientist. The author also describes classic machine learning algorithms, from their mathematical foundations to real-world applications. Visualization tools are reviewed, and their central importance in data science is highlighted. Classical statistics is addressed to help readers think critically about the interpretation of data and its common pitfalls. The clear communication of technical results, which is perhaps the most undertrained of data science skills, is given its own chapter, and all topics are explained in the context of solving real-world data problems. The book also features: • Extensive sample code and tutorials using Python™ along with its technical libraries • Core technologies of “Big Data,” including their strengths and limitations and how they can be used to solve real-world problems • Coverage of the practical realities of the tools, keeping theory to a minimum; however, when theory is presented, it is done in an intuitive way to encourage critical thinking and creativity • A wide variety of case studies from industry • Practical advice on the realities of being a data scientist today, including the overall workflow, where time is spent, the types of datasets worked on, and the skill sets needed The Data Science Handbook is an ideal resource for data analysis methodology and big data software tools. The book is appropriate for people who want to practice data science, but lack the required skill sets. This includes software professionals who need to better understand analytics and statisticians who need to understand software. Modern data science is a unified discipline, and it is presented as such. This book is also an appropriate reference for researchers and entry-level graduate students who need to learn real-world analytics and expand their skill set. FIELD CADY is the data scientist at the Allen Institute for Artificial Intelligence, where he develops tools that use machine learning to mine scientific literature. He has also worked at Google and several Big Data startups. He has a BS in physics and math from Stanford University, and an MS in computer science from Carnegie Mellon. Drawing on the authors’ extensive research in the analysis of categorical longitudinal data, Latent Markov Models for Longitudinal Data focuses on the formulation of latent Markov models and the practical use of these models. Numerous examples illustrate how latent Markov models are used in economics, education, sociology, and other fields. The R and MATLAB® routines used for the examples are available on the authors’ website. The book provides you with the essential background on latent variable models, particularly the latent class model. It discusses how the Markov chain model and the latent class model represent a useful paradigm for latent Markov models. The authors illustrate the assumptions of the basic version of the latent Markov model and introduce maximum likelihood estimation through the Expectation-Maximization algorithm. They also cover constrained versions of the basic latent Markov model, describe the inclusion of the individual covariates, and address the random effects and multilevel extensions of the model. After covering advanced topics, the book concludes with a discussion on Bayesian inference as an alternative to maximum likelihood inference. As longitudinal data become increasingly relevant in many fields, researchers must rely on specific statistical and econometric models tailored to their application. A complete overview of latent Markov models, this book demonstrates how to use the models in three types of analysis: transition analysis with measurement errors, analyses that consider unobserved heterogeneity, and finding clusters of units and studying the transition between the clusters. Hidden Markov Models (HMMs) are ubiquitously used in applications such as speech recognition and gene prediction that involve inferring latent variables given observations. For the past few decades, the predominant technique used to infer these hidden variables has been the Baum-Welch algorithm. This thesis utilizes insights from two related fields. The first insight is from Angluin's seminal paper on learning regular sets from queries and counterexamples, which produces a simple and intuitive algorithm that efficiently learns deterministic finite automata. The second insight follows from a careful analysis of the representation of HMMs as matrices and realizing that matrices hold deeper meaning than simply entities used to represent the HMMs. This thesis takes Angluin's approach and nonnegative matrix factorization and applies them to learning HMMs. Angluin's approach fails and the reasons are discussed. The matrix factorization approach is successful, allowing us to produce a novel method of learning HMMs. The new method is combined with Baum-Welch into a hybrid algorithm. We evaluate the algorithm by comparing its performance in learning selected HMMs to the Baum-Welch algorithm. We empirically show that our algorithm is able to perform better than the Baum-Welch algorithm for HMMs with at most six states that have dense output and transition matrices. For these HMMs, our algorithm is shown to perform 22.65% better on average by the Kullback-Liebler measure. The present textbook contains the recordsof a two–semester course on que- ing theory, including an introduction to matrix–analytic methods. This course comprises four hours oflectures and two hours of exercises per week andhas been taughtattheUniversity of Trier, Germany, for about ten years in - quence. The course is directed to last year undergraduate and?rst year gr- uate students of applied probability and computer science, who have already completed an introduction to probability theory. Its purpose is to present - terial that is close enough to concrete queueing models and their applications, while providing a sound mathematical foundation for the analysis of these. Thus the goal of the present book is two–fold. On the one hand, students who are mainly interested in applications easily feel bored by elaborate mathematical questions in the theory of stochastic processes. The presentation of the mathematical foundations in our courses is chosen to cover only the necessary results, which are needed for a solid foundation of the methods of queueing analysis. Further, students oriented - wards applications expect to have a justi?cation for their mathematical efforts in terms of immediate use in queueing analysis. This is the main reason why we have decided to introduce new mathematical concepts only when they will be used in the immediate sequel. On the other hand, students of applied probability do not want any heur- tic derivations just for the sake of yielding fast results for the model at hand. What Is Hidden Markov Model A hidden Markov model, often known as an HMM, is a type of statistical Markov model. In an HMM, the system being represented is considered to be a Markov process, which we will refer to as it, with states that cannot be observed (thus the name "hidden"). In order to fulfill one of the requirements for the definition of HMM, there must be a measurable process whose results are "influenced" by those of another process in a certain way. Since it is not possible to directly see, the objective here is to learn about via observing. HMM contains the additional criterion that the result of an event that occurs at a certain time must be "influenced" solely by the outcome of an event that occurs at that time, and that the outcomes of an event that occurs at and at must be conditionally independent of at provided that it occurs at a particular time. How You Will Benefit (I) Insights, and validations about the following topics: Chapter 1: Hidden Markov model Chapter 2: Markov chain Chapter 3: Viterbi algorithm Chapter 4: Expectation-maximization algorithm Chapter 5: Baum-Welch algorithm Chapter 6: Metropolis-Hastings algorithm Chapter 7: Bayesian network Chapter 8: Gibbs sampling Chapter 9: Mixture model Chapter 10: Forward algorithm (II) Answering the public top questions about

hidden markov model. (III) Real world examples for the usage of hidden markov model in many fields. Who This Book Is For Professionals, undergraduate and graduate students, enthusiasts, hobbyists, and those who want to go beyond basic knowledge or information for any kind of hidden markov model. What is Artificial Intelligence Series The artificial intelligence book series provides comprehensive coverage in over 200 topics. Each ebook covers a specific Artificial Intelligence topic in depth, written by experts in the field. The series aims to give readers a thorough understanding of the concepts, techniques, history and applications of artificial intelligence. Topics covered include machine learning, deep learning, neural networks, computer vision, natural language processing, robotics, ethics and more. The ebooks are written for professionals, students, and anyone interested in learning about the latest developments in this rapidly advancing field. The artificial intelligence book series provides an in-depth yet accessible exploration, from the fundamental concepts to the state-of-the-art research. With over 200 volumes, readers gain a thorough grounding in all aspects of Artificial Intelligence. The ebooks are designed to build knowledge systematically, with later volumes building on the foundations laid by earlier ones. This comprehensive series is an indispensable resource for anyone seeking to develop expertise in artificial intelligence. Hidden Markov models (HMMs) originally emerged in the domain of speech recognition. In recent years, they have attracted growing interest in the area of computer vision as well. This book is a collection of articles on new developments in the theory of HMMs and their application in computer vision. It addresses topics such as handwriting recognition, shape recognition, face and gesture recognition, tracking, and image database retrieval. This book is also published as a special issue of the International Journal of Pattern Recognition and Artificial Intelligence (February 2001). Contents: Introduction: A Simple Complex in Artificial Intelligence and Machine Learning (B H Juang)An Introduction to Hidden Markov Models and Bayesian Networks (Z Chahramani)Multi-Lingual Machine Printed OCR (P Natarajan et al.)Using a Statistical Language Model to Improve the Performance of an HMM-Based Cursive Handwriting Recognition System (U-V Marti & H Bunke)A 2-D HMM Method for Offline Handwritten Character Recognition (H-S Park et al.)Data-Driven Design of HMM Topology for Online Handwriting Recognition (J J Lee et al.)Hidden Markov Models for Modeling and Recognizing Gesture Under Variation (A D Wilson & A F Bobick)Sentence Lipreading Using Hidden Markov Model with Integrated Grammar (K Yu et al.)Tracking and Surveillance in Wide-Area Spatial Environments Using the Abstract Hidden Markov Model (H H Bui et al.)Shape Tracking and Production Using Hidden Markov Models (T Caelli et al.)An Integrated Approach to Shape and Color-Based Image Retrieval of Rotated Objects Using Hidden Markov Models (S Müller et al.) Readership: Graduate students of computer science, electrical engineering and related fields, as well as researchers at academic and industrial institutions. Keywords:Hidden Markov Models;Gesture Recognitoin;Bayesian Networks;Optical Character Recognition;Handwriting Character Recognition;Cartography;Shape Extraction;Image Feature Extraction. This book explores important aspects of Markov and hidden Markov processes and the applications of these ideas to various problems in computational biology. The book starts from first principles, so that no previous knowledge of probability is necessary. However, the work is rigorous and mathematical, making it useful to engineers and mathematicians, even those not interested in biological applications. A range of exercises is provided, including drills to familiarize the reader with concepts and more advanced problems that require deep thinking about the theory. Biological applications are taken from post-genomic biology, especially genomics and proteomics. The topics examined include standard material such as the Perron-Frobenius theorem, transient and recurrent states, hitting probabilities and hitting times, maximum likelihood estimation, the Viterbi algorithm, and the Baum-Welch algorithm. The book contains discussions of extremely useful topics not usually seen at the basic level, such as ergodicity of Markov processes, Markov Chain Monte Carlo (MCMC), information theory, and large deviation theory for both i.i.d and Markov processes. The book also presents state-of-the-art realization theory for hidden Markov models. Among biological applications, it offers an in-depth look at the BLAST (Basic Local Alignment Search Technique) algorithm, including a comprehensive explanation of the underlying theory. Other applications such as profile hidden Markov models are also explored. There are many different types of convergence within economics, as well as several methods to analyse each of them. This book addresses the concept of real economic convergence or the gradual levelling-off of GDP (gross domestic product) per capita rates across economies. In addition to a detailed, holistic overview of the history and theory, the authors include a description of two modern methods of assessing the occurrence and rate of convergence, BMA-based and HMM-based, as well as the results of the empirical analysis. Readers will have access not only to the conventional econometric approach of β convergence but also to an alternative one, allowing for the convergence issue to be expressed in the context of automatic pattern recognition. This approach is universal as it can be adapted to a variety of input data. The lowest aggregation level study investigates regional convergence through the case of Polish voivodships, where convergence towards the leader is tested. On a higher level of aggregation, the authors examine the existence of GDP convergence in such groups as the EU28, North Africa and the Middle East, sub-Saharan Africa, South America, Caribbean, South-East Asia, Australia and Oceania, or post-socialist countries. For each group, the real β convergence is tested using the two above-mentioned approaches. The results are widely discussed, broadly illustrated, interpreted, and compared. The analysis allows readers to draw interesting conclusions about the causes of convergence or the drivers behind divergence. The book will stimulate further research in the field, but the research was conducted from the point of view of individual countries. Here is a work that adds much to the sum of our knowledge in a key area of science today. It is concerned with the estimation of discrete-time semi-Markov and hidden semi-Markov processes. A unique feature of the book is the use of discrete time, especially useful in some specific applications where the time scale is intrinsically discrete. The models presented in the book are specifically adapted to reliability studies and DNA analysis. The book is mainly intended for applied probabilists and statisticians interested in semi-Markov chains theory, reliability and DNA analysis, and for theoretical oriented reliability and bioinformatics engineers. NEW YORK TIMES BESTSELLER Shortlisted for the Financial Times/McKinsey Business Book of the Year Award The unbelievable story of a secretive mathematician who pioneered the era of the algorithm--and made $23 billion doing it. Jim Simons is the greatest money maker in modern financial history. No other investor--Warren Buffett, Peter Lynch, Ray Dalio, Steve Cohen, or George Soros--can touch his record. Since 1988, Renaissance's signature Medallion fund has generated average annual returns of 66 percent. The firm has earned profits of more than $100 billion; Simons is worth twenty-three billion dollars. Drawing on unprecedented access to Simons and dozens of current and former employees, Zuckerman, a veteran Wall Street Journal investigative reporter, tells the gripping story of how a world-class mathematician and former code breaker mastered the market. Simons pioneered a data-driven, algorithmic approach that's sweeping the world. As Renaissance became a market force, its executives began influencing the world beyond finance. Simons became a major figure in scientific research, education, and liberal politics. Senior executive Robert Mercer is more responsible than anyone else for the Trump presidency, placing Steve Bannon in the campaign and funding Trump's victorious 2016 effort. Mercer also impacted the campaign behind Brexit. The Man Who Solved the Market is a portrait of a modern-day Midas who remade markets in his own image, but failed to anticipate how his success would impact his firm and his country. It's also a story of what Simons's revolution means for the rest of us. This proceedings set contains 85 selected full papers presentedat the 3rd International Conference on Modelling, Computation and Optimization in Information Systems and Management Sciences - MCO 2015, held on May 11–13, 2015 at Lorraine University, France. The present part II of the 2 volume set includes articles devoted to Data analysis and Data mining, Heuristic / Meta heuristic methods for operational research applications, Optimization applied to surveillance and threat detection, Maintenance and Scheduling, Post Crises banking and eco-finance modelling, Transportation, as well as Technologies and methods for multi-stakeholder decision analysis in public settings. I present a Dempster-Shafer approach to estimating limits from Poisson counting data with nuisance parameters and two new methods, Conditional Baum-Welch and Dynamic Model Surgery, for achieving maximum-likelihood or maximum a-posteriori estimates of the parameters of Profile hidden Markov Models. Dempster-Shafer (DS) is a statistical framework that generalizes Bayesian statistics. DS calculus augments traditional probability by allowing mass to be distributed over power sets of the event space. This eliminates the Bayesian dependence on prior distributions while allowing the incorporation of prior information when it is available. I use the Poisson Dempster-Shafer model (DSM) to derive a posterior DSM for the "Banff upper limits challenge" three-Poisson model. Profile hidden Markov Models (Profile

HMMs) are widely used for protein sequence family modeling. The algorithm commonly used to estimate the parameters of Profile HMMs, Baum-Welch (BW), is prone to prematurely converge to local optima. I provide a description and proof of the Conditional Baum-Welch (CBW) algorithm, and show that it is able to parameterize Profile HMMs better than BW under a range of conditions including both protein and DNA sequence family models. I also introduce the Dynamic Model Surgery (DMS) method, which can be applied to either BW or CBW to help them achieve higher maxima by dynamically altering the structure of the Profile HMM during BW or CBW training. I conclude by describing the results of an application of these methods to the transposon (interspersed repeat) modeling problem that originally inspired the research. This book presents, in an integrated form, both the analysis and synthesis of three different types of hidden Markov models. Unlike other books on the subject, it is generic and does not focus on a specific theme, e.g. speech processing. Moreover, it presents the translation of hidden Markov models' concepts from the domain of formal mathematics into computer codes using MATLAB®. The unique feature of this book is that the theoretical concepts are first presented using an intuition-based approach followed by the description of the fundamental algorithms behind hidden Markov models using MATLAB®. This approach, by means of analysis followed by synthesis, is suitable for those who want to study the subject using a more empirical approach. Key Selling Points: Presents a broad range of concepts related to Hidden Markov Models (HMM), from simple problems to advanced theory Covers the analysis of both continuous and discrete Markov chains Discusses the translation of HMM concepts from the realm of formal mathematics into computer code Offers many examples to supplement mathematical notation when explaining new concepts This text provides an introduction to hidden Markov models (HMMs) for the dynamical systems community. It is a valuable text for third or fourth year undergraduates studying engineering, mathematics, or science that includes work in probability, linear algebra and differential equations. The book presents algorithms for using HMMs, and it explains the derivation of those algorithms. It presents Kalman filtering as the extension to a continuous state space of a basic HMM algorithm. The book concludes with an application to biomedical signals. This text is distinctive for providing essential introductory material as well as presenting enough of the theory behind the basic algorithms so that the reader can use it as a guide to developing their own variants. We address the problem of learning discrete hidden Markov models from very long sequences of observations. Incremental versions of the Baum-Welch algorithm that approximate the beta-values used in the backward procedure are commonly used for this problem since their memory complexity is independent of the sequence length. However, traditional approaches have two main disadvantages: the approximation of the beta-values deviates far from the real values, and the learning algorithm requires previous knowledge of the topology of the model. This dissertation describes a new incremental Baum-Welch algorithm with a novel backward procedure that improves the approximation of the â-values based on a one-step lookahead in the training sequence and investigates heuristics to prune unnecessary states from an initial complex model. Two new approaches for pruning, greedy and controlled, are introduced and a novel method for identification of ill-conditioned models is presented. Incremental learning of multiple independent observations is also investigated. We justify the new approaches analytically and report empirical results that show they converge faster than the traditional Baum-Welch algorithm using fewer computer resources. Furthermore, we demonstrate that the new learning algorithms converge faster than the previous incremental approaches and can be used to perform online learning of high-quality models useful for classification tasks. Finally, this dissertation explores the use of the new algorithms for anomaly detection in computer systems, that improve our previous research work on detectors based on hidden Markov models integrated into real-world monitoring systems of high-performance computers. Please note that the content of this book primarily consists of articles available from Wikipedia or other free sources online. Pages: 102. Chapters: Bayesian networks, Markov models, Markov chain, Queueing theory, Snakes and ladders, Hidden Markov model, Poisson process, Reinforcement learning, Burst error, Mark V Shaney, Kalman filter, PageRank, Multiple sequence alignment, Models of DNA evolution, Forward-backward algorithm, Path dependence, Belief propagation, Structural equation modeling, Viterbi algorithm, Algorithmic composition, Part-of-speech tagging, Gene prediction, Google matrix, Markov switching multifractal, Conditional random field, Influence diagram, Markov random field, Markov chain Monte Carlo, Bayesian inference in phylogeny, Graphical models for protein structure, Queueing model, Pop music automation, Dynamic Markov compression, Subshift of finite type, Stochastic matrix, Language model, Examples of Markov chains, Hierarchical Bayes model, Factor graph, Markov property, Path analysis, Detailed balance, Bernoulli scheme, Variational message passing, Latent variable, Layered hidden Markov model, Markov partition, Hierarchical hidden Markov model, Discrete phase-type distribution, GLIMMER, Kolmogorov backward equations, Baum-Welch algorithm, Dependability state model, Plate notation, Junction tree algorithm, Variable-order Bayesian network, Iterative Viterbi decoding, Markovian discrimination, Forward algorithm, Entropy rate, Hidden semi-Markov model, Maximum entropy Markov model, Population process, Markov blanket, Collider, Soft output Viterbi algorithm, Moral graph, M-separation, Dynamics of Markovian particles, Markov chain geostatistics, Quantum Markov chain, Transiogram, Ancestral graph, Causal Markov condition, Poisson hidden Markov model, Dynamic Bayesian network. Please note that the content of this book primarily consists of articles available from Wikipedia or other free sources online. Pages: 90. Chapters: Absorbing Markov chain, Algorithmic composition, Baum-Welch algorithm, Bernoulli scheme, Burst error, Dependability state model, Detailed balance, Discrete phase-type distribution, Dynamics of Markovian particles, Dynamic Markov compression, Entropy rate, Examples of Markov chains, Forward algorithm, Forward-backward algorithm, Gene prediction, GLIMMER, Google matrix, Hidden Markov model, Iterative Viterbi decoding, Kalman filter, Language model, Markovian discrimination, Markov chain geostatistics, Markov chain Monte Carlo, Markov partition, Markov property, Markov switching multifractal, Mark V Shaney, Maximum-entropy Markov model, Models of DNA evolution, Multiple sequence alignment, PageRank, Part-of-speech tagging, Path dependence, Population process, Pop music automation, Quantum Markov chain, Queueing model, Queueing theory, Reinforcement learning, Snakes and Ladders, Soft output Viterbi algorithm, Stochastic matrix, Transiogram, Variable-order Bayesian network, Variable-order Markov model. Excerpt: The Kalman filter, also known as linear quadratic estimation (LQE), is an algorithm that uses a series of measurements observed over time, containing noise (random variations) and other inaccuracies, and produces estimates of unknown variables that tend to be more precise than those based on a single measurement alone. More formally, the Kalman filter operates recursively on streams of noisy input data to produce a statistically optimal estimate of the underlying system state. The filter is named for Rudolf (Rudy) E. Kalman, one of the primary developers of its theory. The Kalman filter has numerous applications in technology. A common application is for guidance, navigation and control of vehicles, particularly aircraft and spacecraft. Furthermore, the Kalman filter is a widely applied concept in time... The past decade has seen powerful new computational tools for modeling which combine a Bayesian approach with recent Monte simulation techniques based on Markov chains. This book is the first to offer a systematic presentation of the Bayesian perspective of finite mixture modelling. The book is designed to show finite mixture and Markov switching models are formulated, what structures they imply on the data, their potential uses, and how they are estimated. Presenting its concepts informally without sacrificing mathematical correctness, it will serve a wide readership including statisticians as well as biologists, economists, engineers, financial and market researchers.

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